



Communication Test for 'MatrikonOPC Server for SCADA DNP 3' with RTDS

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Communication Test for ‘MatrikonOPC Server for SCADA DNP 3’ with RTDS

by Qiuwei Wu, Seung Tae Cha, Arshad Saleem, Jacob
Østergaard

Document History

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Abbreviation

DNP	Distributed Network Protocol
OPC	Open Connectivity (OLE for process control)
OLE	Object Linking and Embedding
RTDS	Real Time Digital Simulator
SCADA	Supervisory Control and Data Acquisition

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1 Test Purpose and System Layout

The communication test is part of the work for the ‘Wind in Øresund’ project. The objective of the ‘Wind in Øresund’ project is to build a demonstration and education system of power system operation and control with a RTDS and a SCADA system.

In the demonstration and education system, the RTDS is able to communicate with external systems using the DNP 3 protocol. The SCADA system is expected to use the OPC protocol. Therefore, it is necessary to have a protocol converter between the RTDS and the SCADA system to enable the communication between the RTDS and the SCADA system. On top of that, the OPC protocol is more widely used protocol compared to the DNP 3 protocol. It is very nice to have the OPC interface for future system extension.

The ‘MatrikonOPC server for SCADA DNP 3’ is a protocol converter to enable the communication between the DNP 3 protocol and the OPC protocol. The purpose of the communication test for ‘MatrikonOPC server for SCADA DNP 3’ with RTDS is to verify the data exchange between the ‘MatrikonOPC server for SCADA DNP 3’ and the RTDS using the DNP 3 protocol.

The system layout for the communication testing is illustrated in Figure 1.

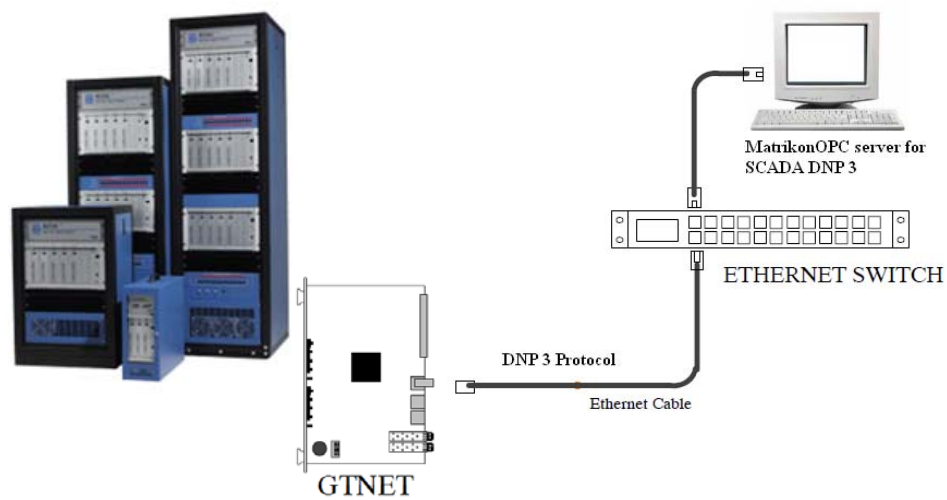


Figure 1 System Layout for Communication Test

In the communication test system, the 'MatrikonOPC server for SCADA DNP 3' is installed on a computer. Therefore, the computer acts as the protocol server for DNP 3 and OPC protocols. The RTDS is connected to the server by Ethernet and will communicate with the server using DNP 3 protocol.

2 Study Case in RTDS

In order to avoid the ambiguity, the terms of ‘status’ and ‘control’ are used for values from the simulated system and the values back to the simulated system, respectively.

In order to test the data exchange between the RTDS and ‘MatrikonOPC server for SCADA DNP 3’, a small study case is simulated in RTDS.

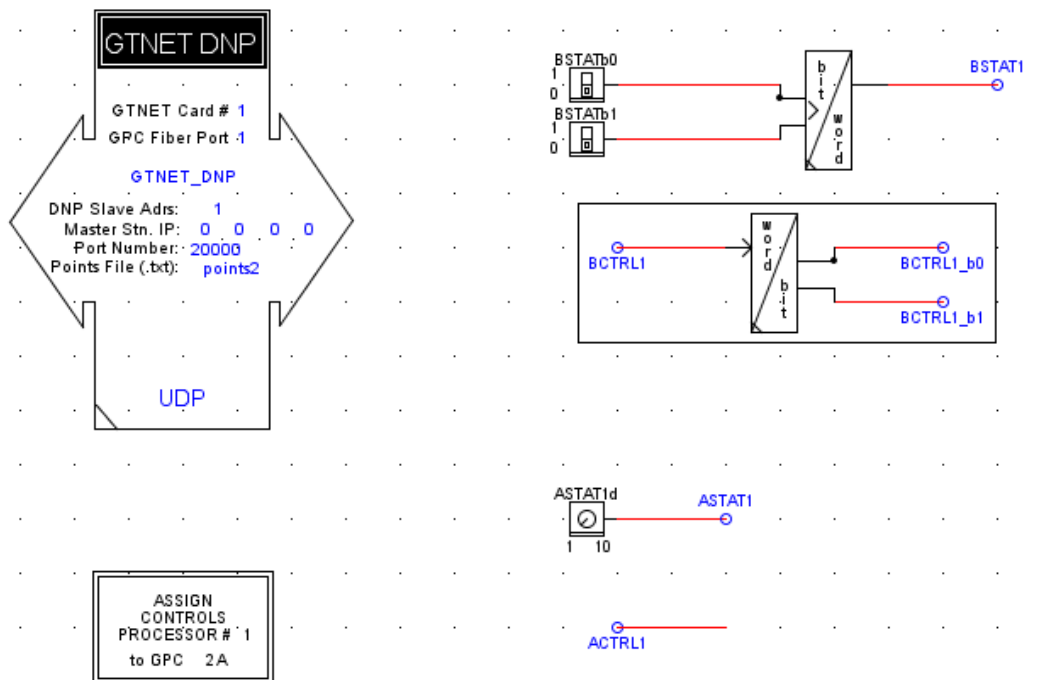


Figure 2 Study Case in RTDS for Communication Test

In order to test the data transport from the RTDS to the ‘MatrikonOPC server for SCADA DNP 3’, in the study case, two binary status variables, BSTATb0 and BSTATb1, are defined to check the binary status data transport from the RTDS to the ‘MatrikonOPC server for SCADA DNP 3’. At the same time, one analog status variable, ASTAT1, is defined to check the analog data transport from the RTDS to the ‘MatrikonOPC server for SCADA DNP 3’.

In order to test the data transport from the 'MatrikonOPC server for SCADA DNP 3' and to the RTDS, in the study case, two binary control variables, BCTRL1_b0 and BCTRL1_b1, are defined to check the binary data transport from the 'MatrikonOPC server for SCADA DNP 3' to the RTDS. One analog control variable, ACTRL1, is defined to check the analog data transport from the 'MatrikonOPC server for SCADA DNP 3' to the RTDS.

3 Server Setup and Data Polling in MatrikonOPC Server for SCADA DNP 3

In order to realize the communication between the RTDS and the 'MatrikonOPC server for SCADA DNP 3', the connection between the RTDS and the 'MatrikonOPC server for SCADA DNP 3' has to be established. At the same time, in order to view the status data from the RTDS and set the control data for the RTDS, the specific settings have to be done in the MatrikonOPC Explorer. The details of the connection setting and the settings in MatrikonOPC Explorer are presented in the following sections.

3.1 Connection Setting between RTDS and 'MatrikonOPC Server for SCADA DNP 3'

The connection setting between the RTDS and the 'MatrikonOPC server for SCADA DNP 3' is comprised three steps which are described below.

1. Network channel setting
2. Network host setting
3. DNP 3 unit setting

The network channel setting is presented below.

- Right click 'server configuration' on the MatrikonOPC server for SCADA DNP 3 interface
- Choose 'define new'
- Select 'Network Channel'
- On the network channel setting interface, key in the name of the network channel and choose the '2 datagram UDP' protocol

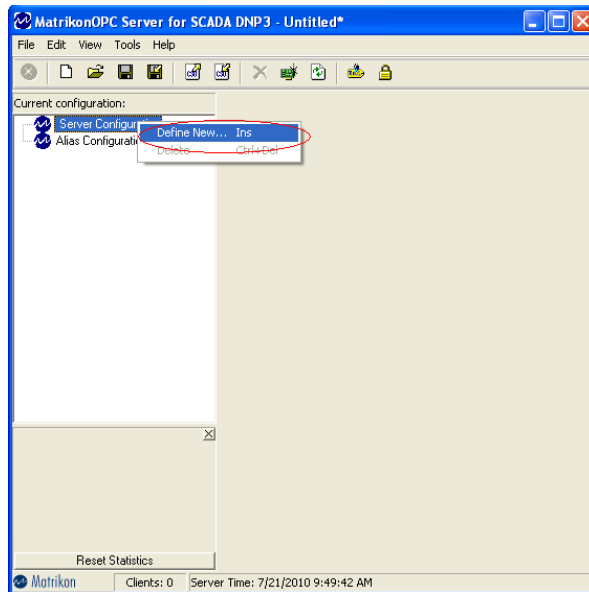


Figure 3 Define New Server Configuration

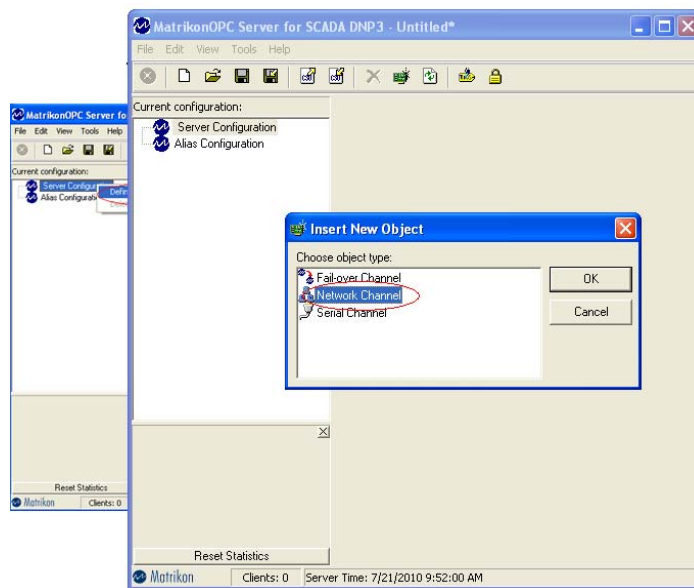


Figure 4 Network Channel Selection

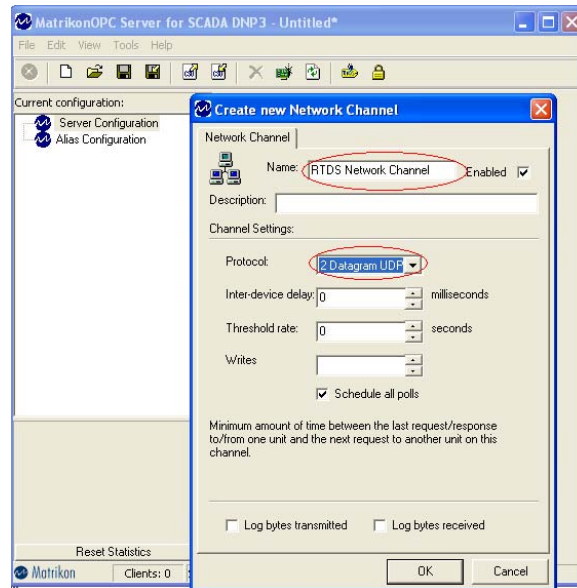


Figure 5 Network Channel Setting

The network host setting is described below.

- Right click the created network channel
- Choose 'define new'
- Select 'Network Host'
- On the network host setting interface, key in the network host name, IP address of the GTNET card of the RTDS and port number

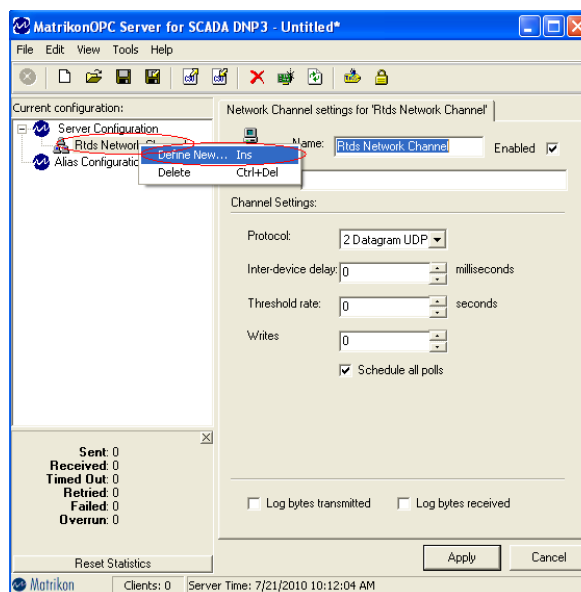


Figure 6 Define New Network Host

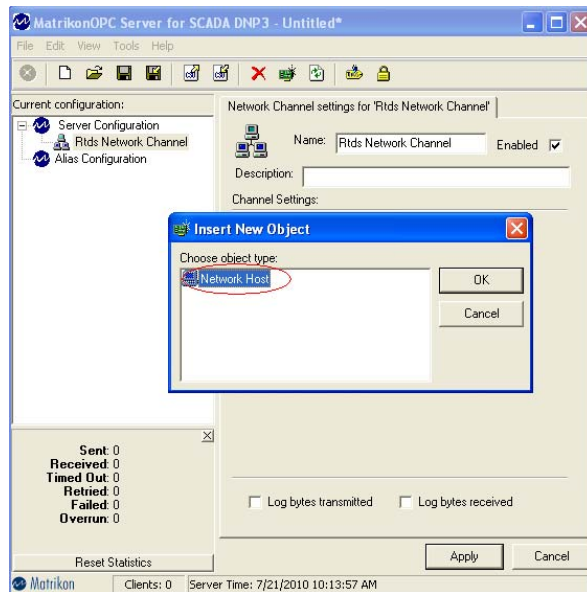


Figure 7 Network Host Selection

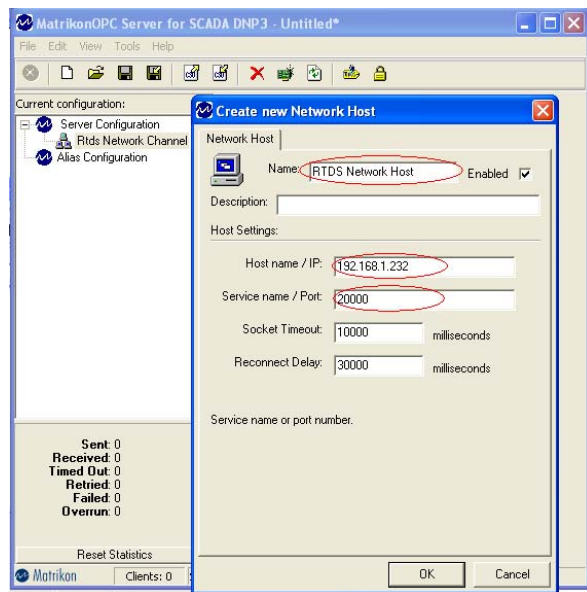


Figure 8 Network Host Setting

The DNP 3 unit setting is described below.

- Right click the created network host
- Choose 'define new'
- Select 'DNP 3 Unit'

- Key in the DNP 3 unit name and keep the rest settings as they are

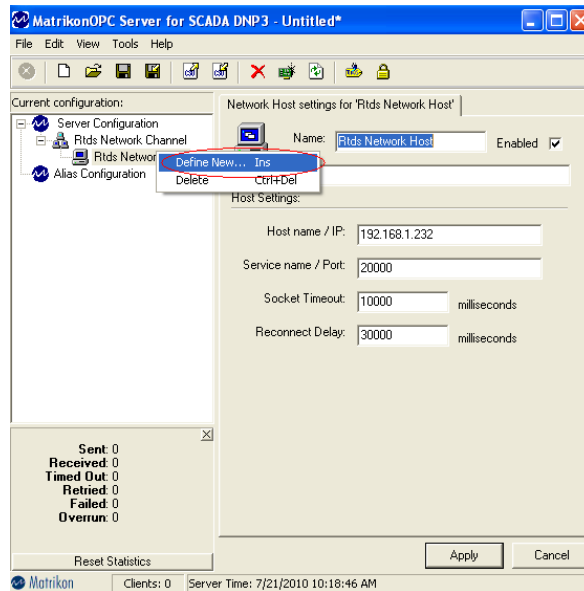


Figure 9 Define New DNP 3 Unit

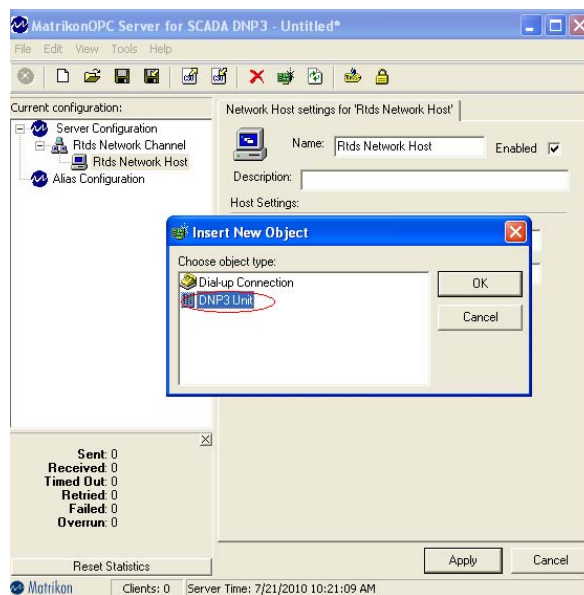


Figure 10 DNP 3 Unit Selection

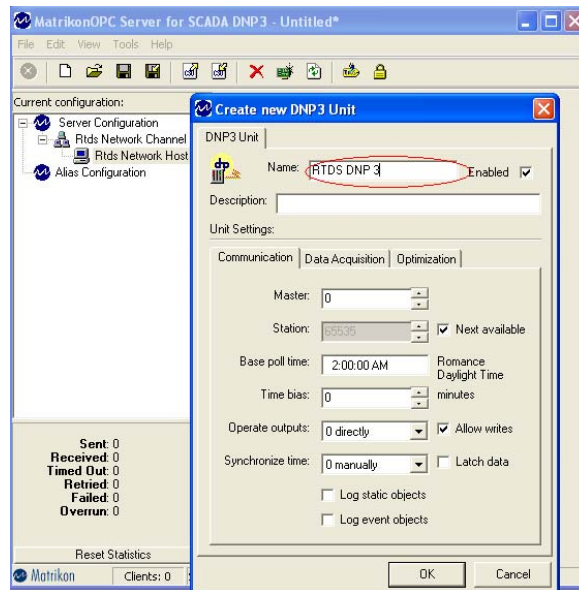


Figure 11 DNP 3 Unit Setting

3.2 Setting in MatrikonOPC Explorer for Status Data Viewing and Control Data Setting

The details of setting in MatrikonOPC Explorer for status data viewing and control data setting are presented below.

1 on the MatrikonOPC server for SCADA DNP 3 interface, choose 'tools->view tags' to open MatrikonOPC explorer tag selection interface

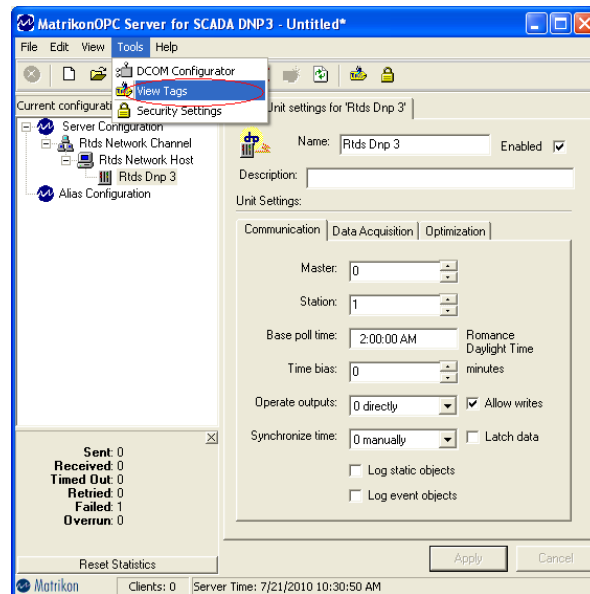


Figure 12 'View Tags' Selection from MatrikonOPC Server for SCADA DNP 3

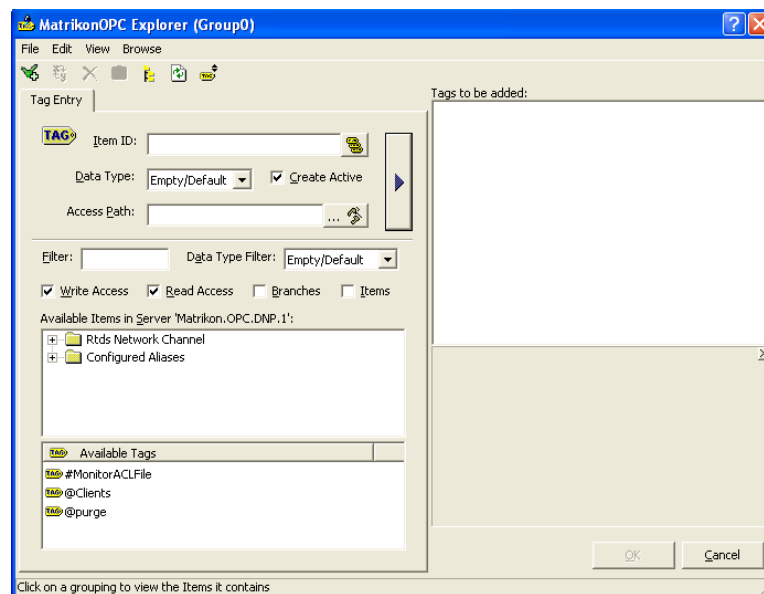


Figure 13 MatrikonOPC Explorer Interface

2 expand the created network channel folder and choose the created DNP 3 unit folder

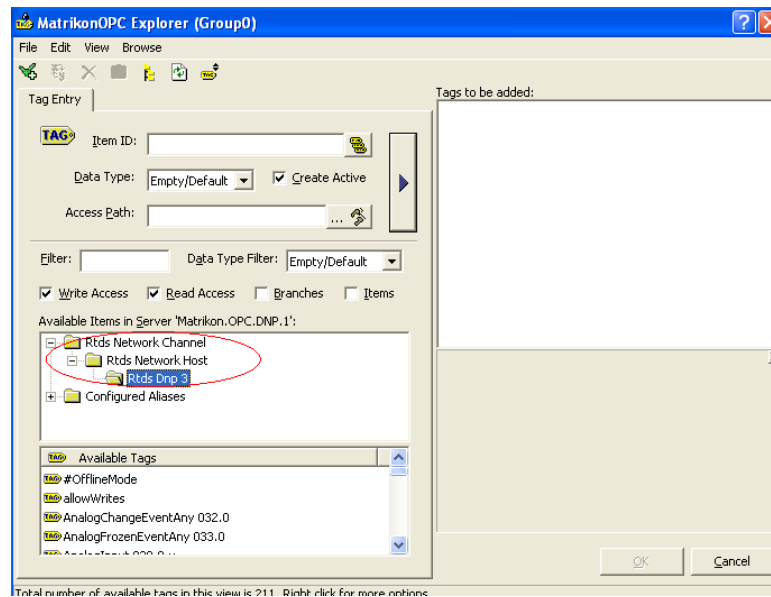


Figure 14 DNP 3 Unit Folder Selection

3 choose the tags for analog inputs and binary inputs for status values and analog and binary outputs for control values

Contents of 'Group0'		
Item ID		Quality
Rtds Network Channel.Rtds Network Host.Rtds Dnp 3.AnalogInput 030.0.0	Analog Status	Good, non-specific
Rtds Network Channel.Rtds Network Host.Rtds Dnp 3.AnalogOutput 040.0.0	Analog Control	Good, non-specific
Rtds Network Channel.Rtds Network Host.Rtds Dnp 3.AnalogOutputBlockShortFP 041.3.0	Analog Control Setting	Good, non-specific
Rtds Network Channel.Rtds Network Host.Rtds Dnp 3.BinaryInput 001.0.0	Binary Status	Good, non-specific
Rtds Network Channel.Rtds Network Host.Rtds Dnp 3.BinaryOutput 010.0.0	Binary Control	Good, non-specific
Rtds Network Channel.Rtds Network Host.Rtds Dnp 3.ControlBlockRelay 012.1.0	Binary Control Setting	Bad, unknown

Figure 15 Tag Selection in MatrikonOPC Explorer

The relationship between tags and data is illustrated in Table 1.

Table 1 Relationship between Tags and Data

Tag Name	Value
AnalogInput 030.0.x	Analog status value
AnalogOutput 040.0.x	Analog control value
AnalogOutputBlockShortFP 041.3.x	Analog control setting
BinaryInput 001.0.x	Binary status value
BinaryOutput 010.0.x	Binary control value
ControlBlockRelay 012.1.x	Binary control setting

4 Test Results

The test results consist of four parts: analog status value, analog control value, binary status value and binary control value.

4.1 Analog Status Value

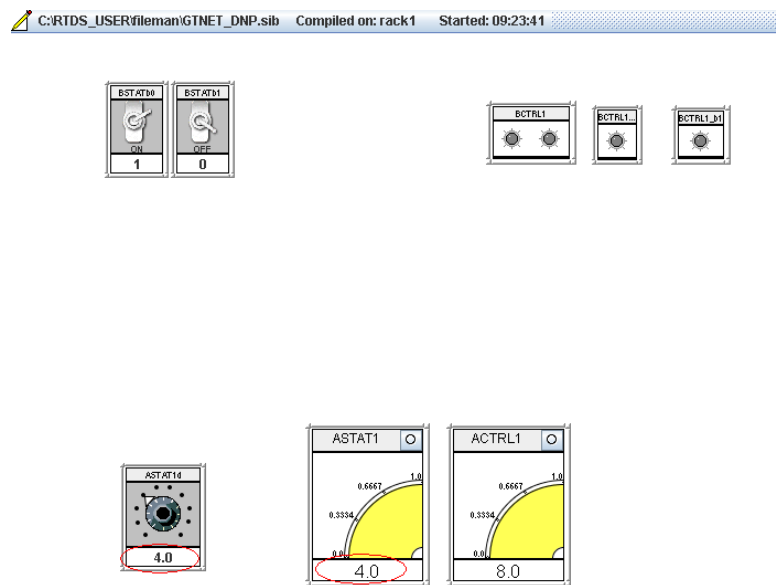


Figure 16 Analog Status Value Test with Value ‘4’ in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		4	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		8	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 17 Analog Status Value Test with Value ‘4’ in MatrikonOPC Explorer

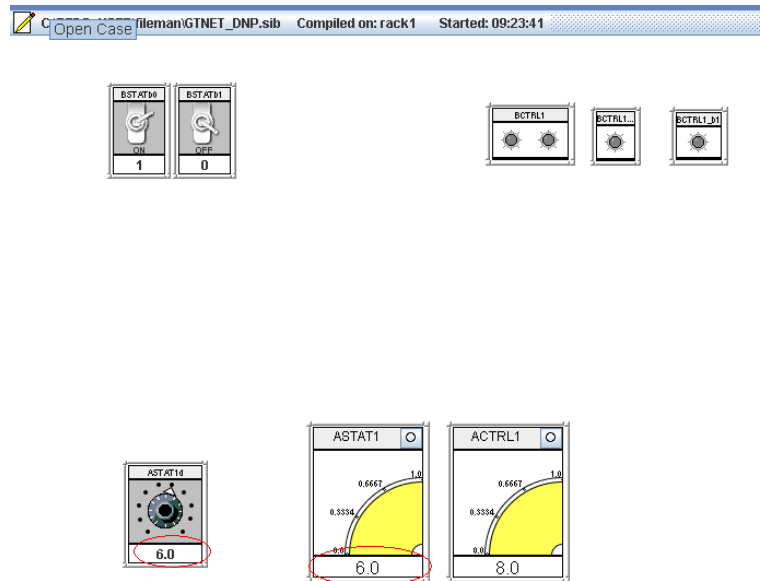


Figure 18 Analog Status Value Test with Value '6' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		8	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 19 Analog Status Value Test with Value '6' in MatrikonOPC Explorer

4.2 Analog Control Value

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		3	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0		0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 20 Analog Control Value Test with Value '3' in MatrikonOPC Explorer

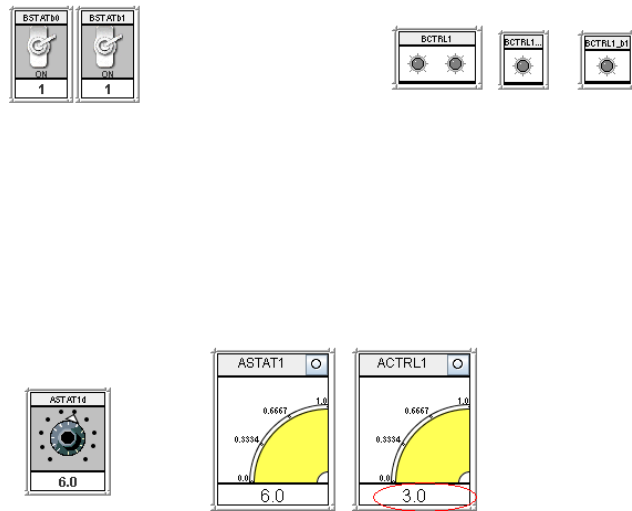


Figure 21 Analog Control Value Test with Value '3' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		7	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShorOFF 041.3.U		0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 22 Analog Control Value Test with Value '7' in MatrikonOPC Explorer

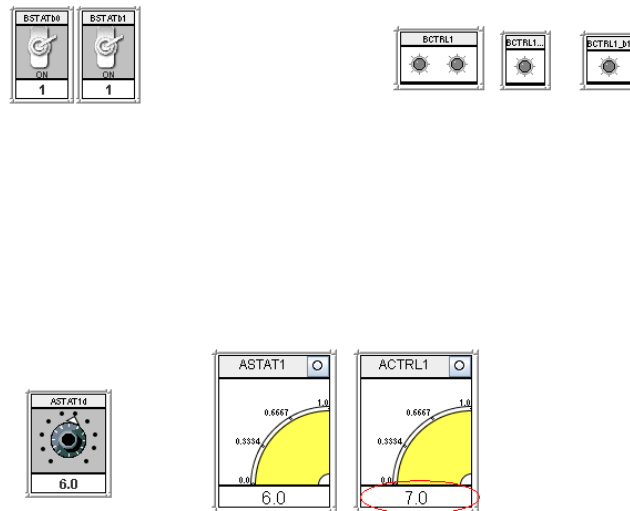


Figure 23 Analog Control Value Test with Value '7' in RTDS

4.3 Binary Status Value

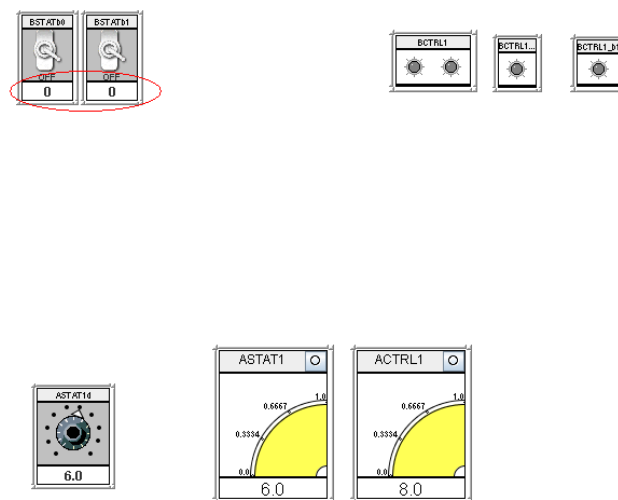


Figure 24 Binary Status Value Test with Value '0, 0' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		8	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 25 Binary Status Value Test with Value '0, 0' in MatrikonOPC Explorer

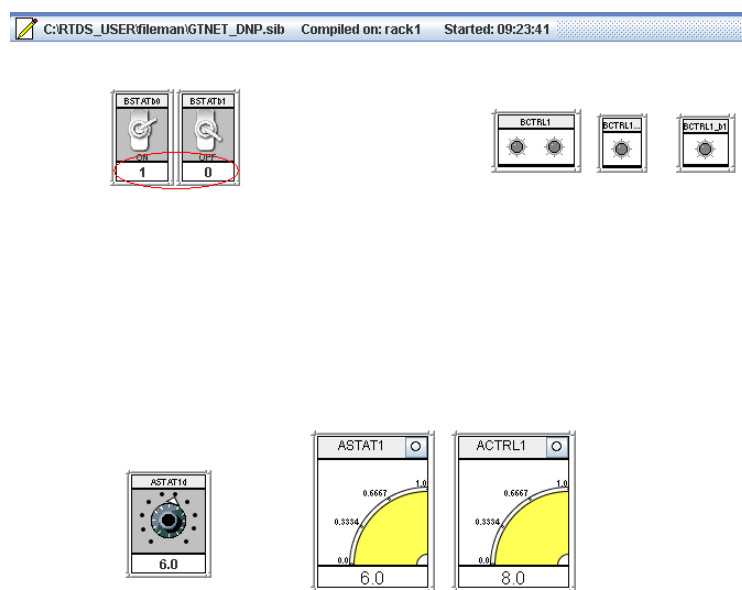


Figure 26 Binary Status Value Test with Value '0, 1' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		8	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 27 Binary Status Value Test with Value '0, 1' in MatrikonOPC Explorer

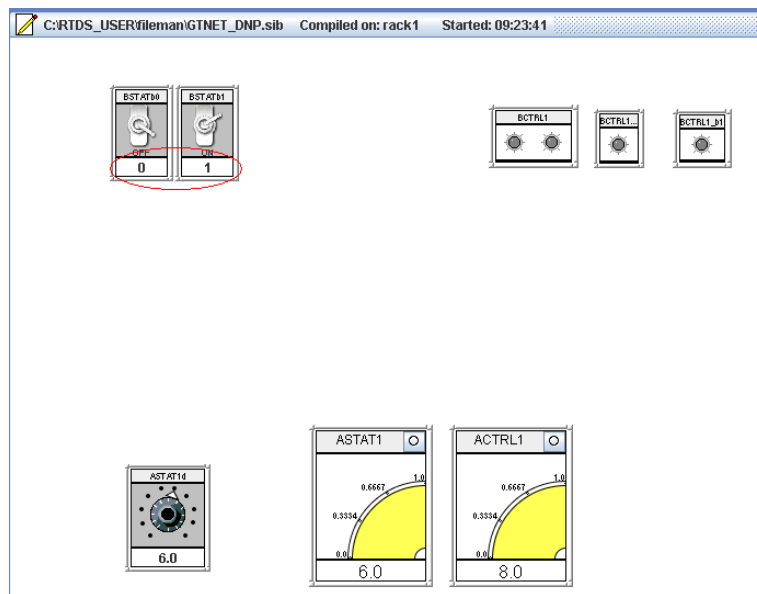


Figure 28 Binary Status Value Test with Value ‘1, 0’ in RTDS

Contents of 'Group0'

Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		8	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 29 Binary Status Value Test with Value ‘1, 0’ in MatrikonOPC Explorer

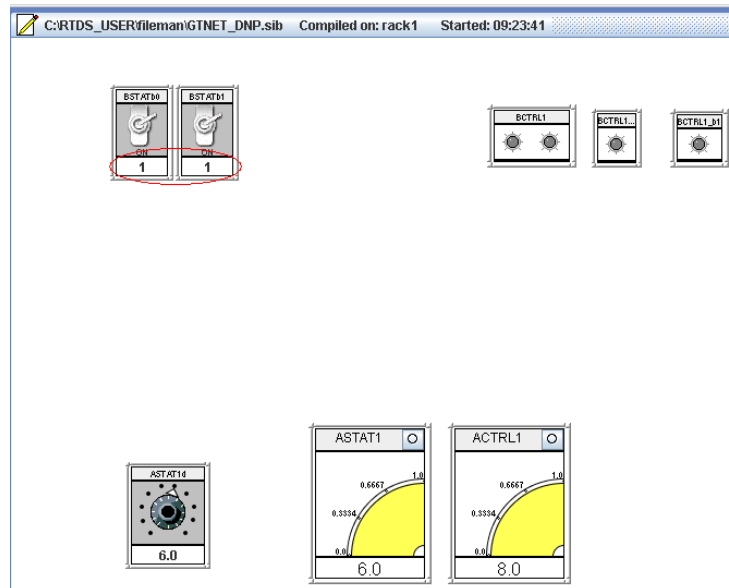


Figure 30 Binary Status Value Test with Value '1, 1' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		8	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 31 Binary Status Value Test with Value '1, 1' in MatrikonOPC Explorer

4.4 Binary Control Value

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		3	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0		0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0			Bad, unknown
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 32 Binary Control Value Test with Value '0, 0' in MatrikonOPC Explorer

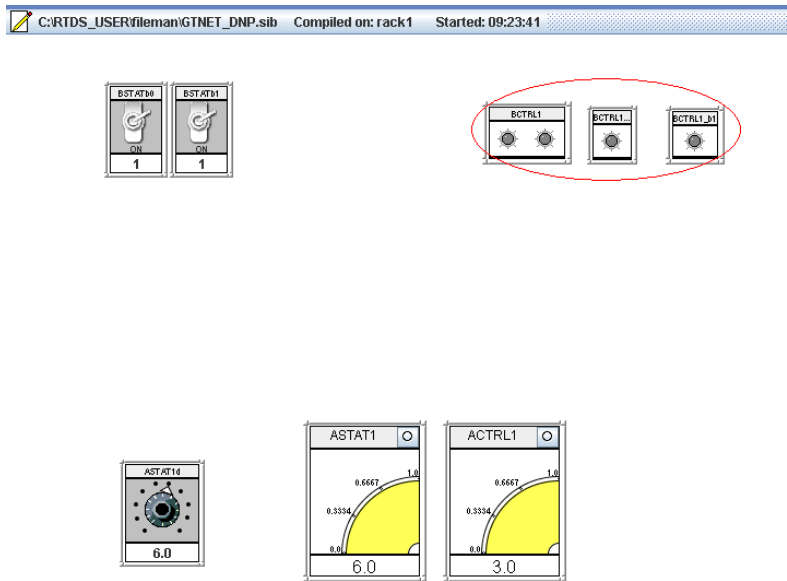


Figure 33 Binary Control Value Test with Value '0, 0' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		3	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0		0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0		3,1,0,0,0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1			Bad, unknown

Figure 34 Binary Control Value Test with Value '0, 1' in MatrikonOPC Explorer

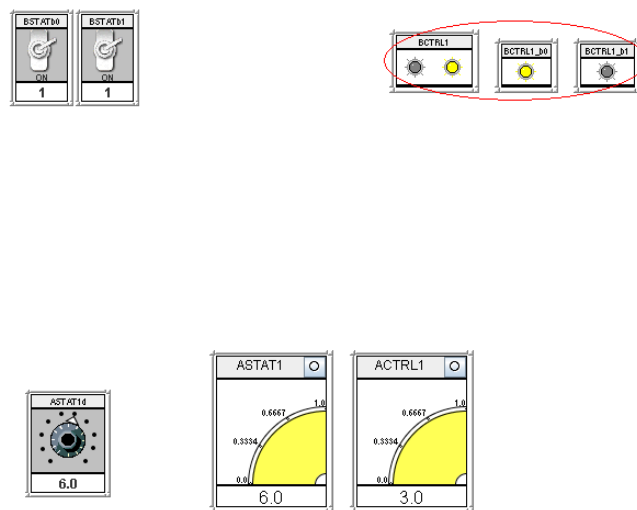


Figure 35 Binary Control Value Test with Value '0, 1' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		3	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0		0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		False	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0		4,1,0,0,0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1		3,1,0,0,0	Good, non-specific

Figure 36 Binary Control Value Test with Value '1, 0' in MatrikonOPC Explorer

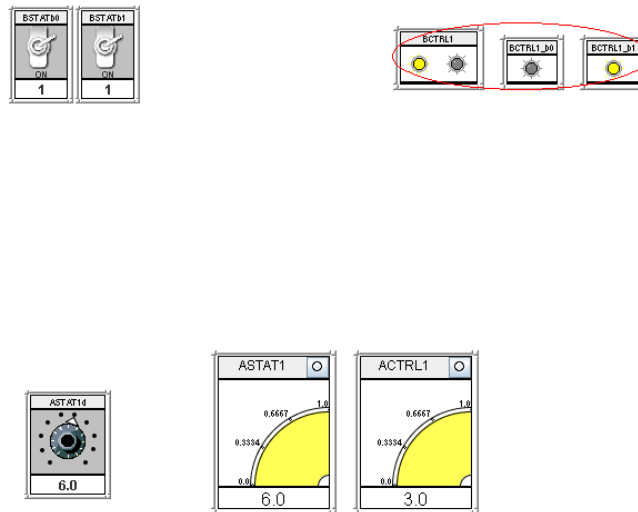


Figure 37 Binary Control Value Test with Value '1, 0' in RTDS

Contents of 'Group0'			
Item ID	Access Path	Value	Quality
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogInput 030.0.0		6	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutput 040.0.0		3	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.AnalogOutputBlockShortFP 041.3.0		0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryInput 001.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.0		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.BinaryOutput 010.0.1		True	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.0		3,1,0,0,0	Good, non-specific
Rtds Network Channel.Rtds Host.Rtds Dnp.ControlBlockRelay 012.1.1		3,1,0,0,0	Good, non-specific

Figure 38 Binary Control Value Test with Value '1, 1' in MatrikonOPC Explorer

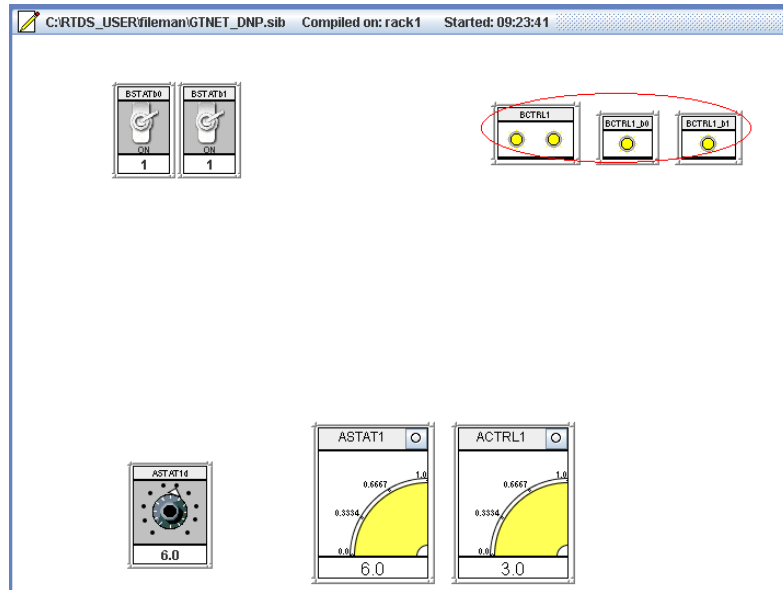


Figure 39 Binary Control Value Test with Value '1, 1' in RTDS

5 Conclusion

The communication test results show that the communication between the RTDS and the 'MatrikonOPC server for SCADA DNP 3' using DNP 3 protocol is pretty good. The analog and binary data transport from the RTDS to the 'MatrikonOPC server for SCADA DNP 3' is successful. The analog and binary data transport from the 'MatrikonOPC server for SCADA DNP 3' to the RTDS is successful too.

Therefore, the 'MatrikonOPC server for SCADA DNP 3' is a good option to serve as the protocol converter between DNP 3 and OPC.

Reference

1. Manual of GTNET DNP, RTDS.
2. MatrikonOPC server for SCADA DNP 3 user manual.
3. MatrikonOPC Explorer user manual.